Sand Lined Trench Systems

Recommended Standards and Guidance for
Performance, Application, Design, and Operation and Maintenance

Washington State Department of
Health

Washington State Department of Health
Office of Community Environmental Health Programs
New Market Industrial Center
7171 Cleanwater Lane, Building 2
PO Box 47826
Olympia, Washington 98504-7826

Tel: 360.236.3063
FAX: 360.236.2251
Webpage: http://www.doh.wa.gov

Preface

The recommended standards contained in this document have been developed for statewide application. Regional differences may, however, result in application of this technology in a manner different than it is presented here. In some localities, greater allowances than those described here may reasonably be granted. In other localities, allowances that are provided for in this document may be restricted. In either setting, the local health officer has full authority in the application of this technology, consistent with Chapter 246-272 WAC and local jurisdictional rules. If any provision of these recommended standards is inconsistent with local jurisdictional rules, regulations, ordinances, policies, procedures, or practices, the local standards take precedence. Application of the recommended standards presented here is at the full discretion of the local health officer.

Local jurisdictional application of these recommended standards may be:

1) **Adopted as part of local rules, regulations or ordinances**—When the recommended standards, either as they are written or modified to more accurately reflect local conditions, are adopted as part of the local rules, their application is governed by local rule authority.

2) **Referred to as technical guidance in the application of the technology**—The recommended standards, either as they are written or modified to more accurately reflect local conditions, may be used locally as technical guidance.

Application of these recommended standards may occur in a manner that combines these two approaches. How these recommended standards are applied at the local jurisdictional level remains at the discretion of the local health officer and the local board of health.

The recommended standards presented here are provided in typical rule language to assist those local jurisdictions where adoption in local rules is the preferred option. Other information and guidance is presented in text boxes with a modified font style to easily distinguish it from the recommended standards.

Acknowledgements—

The Department of Health Wastewater Management Program appreciates the contribution of many persons in the on-going development, review, and up-dating of the Recommended Standards and Guidance documents. The quality of this effort is much improved by the dedication, energy, and input from these persons, including:

- Geoflow, Inc.
- Lombardi and Associates
- Orenco Systems, Inc.
- Puget Sound Water Quality Action Team
- Sun-Mar Corporation
- Washington State On-Site Sewage Association (WOSSA)
- Washington State On-Site Sewage Treatment Technical Review Committee (TRC)
- Waste Water Technologies

Table of Contents

1.0 Introduction —

Sand-lined trenches provide biodegredation or decomposition of wastewater constituents by bringing the wastewater into close contact with a well developed aerobic biological community attached to the surfaces of the filter media. This process requires unsaturated downward flow of the effluent through the filter media. The media is specified as an ASTM C-33 sand or equivalently sized crushed glass. As a departure from the intermittent sand filter, the media is not contained in a watertight vessel. Instead, the media is placed in trenches in the native soil. Proper function requires that influent to the sand filter be distributed over the media in controlled, uniform doses. In order to achieve accurate dosing, these systems require a timer controlled pump with associated pump chambers, electrical components and distribution network, with a minimum of 4 doses per day spread evenly over a 24 hour period. The effluent is absorbed into the native soil at the bottom of the sand-lined trenches, which accomplishes disposal and some further treatment.

Possible Applications:

1. A sand-lined drainfield trench (sand filter) may be selected for a site with excessively permeable (Type 1A) soils. The addition of 24 inches of filter media (coarse sand) to a pressure distribution subsurface soil absorption system provides the wastewater treatment not provided by the Type 1A soil. Treated wastewater is discharged directly to the receiving soil for disposal. See Figure 2.1. If the soil adjacent to the layer of drainrock atop the sand media is Type 1A, then additional filter media sand or an impervious material must be placed between the drainrock and the sidewall and endwall soil. When sand is used for protection against short-circuiting, a minimum of six (6) inches of filter media sand is required. The sand bed under the drainrock will also be widened by six (6) inches on each side. See Figures 2.2 and 2.3. When an impervious material is used, it must be 30 mil PVC and must extend from above the gravel bed to six (6) inches below the gravel/sand interface. See Figure 2.4.

2. A sand-lined drainfield trench (sand filter) may also be selected for a site that has its most suitable soils and treatment conditions at a depth greater than three feet. The filter media (course sand) below the drain rock is used to "reach" deeper soils more suitable for treatment and disposal, and not specifically to enhance wastewater treatment. See Figure 3.

3. A bottomless sand filter is a special case of sand-lined drainfield trench. It may be selected to utilize more suitable soils high in the soil profile for disposal. The containment vessel must be designed by and/or approved by a qualified professional engineer and have a support foundation to prevent vertical and horizontal movement of the vessel. See Figure 4.

Figure 1 - Process Flow

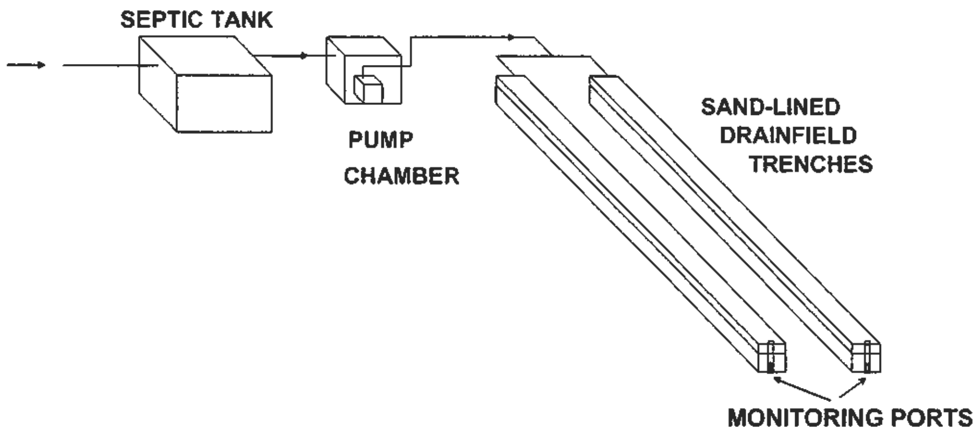


Figure 2.1 - Soil Type 1A at Bottom of Trench

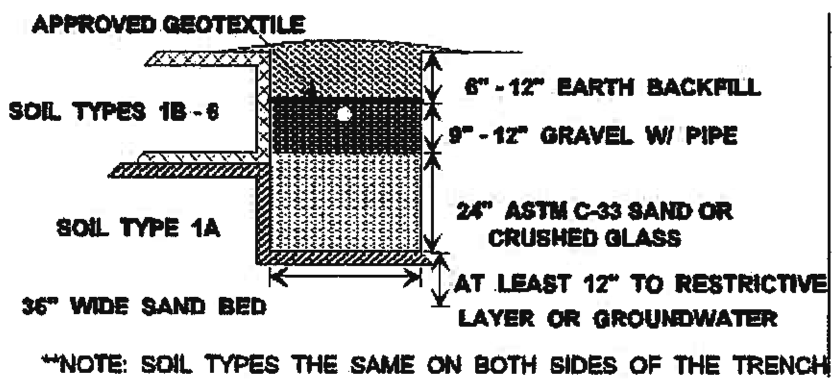


Figure 2.2 - Type 1A Soil Extending up into Gravel Trench Zone (Option 1)

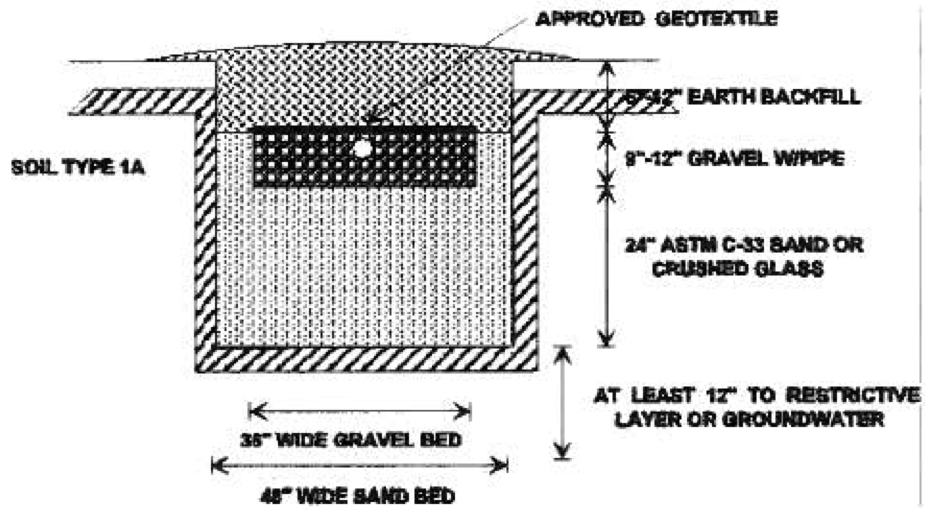


Figure 2.3 - Type 1A Soil Extending up into Gravel Trench Zone (Option 2)

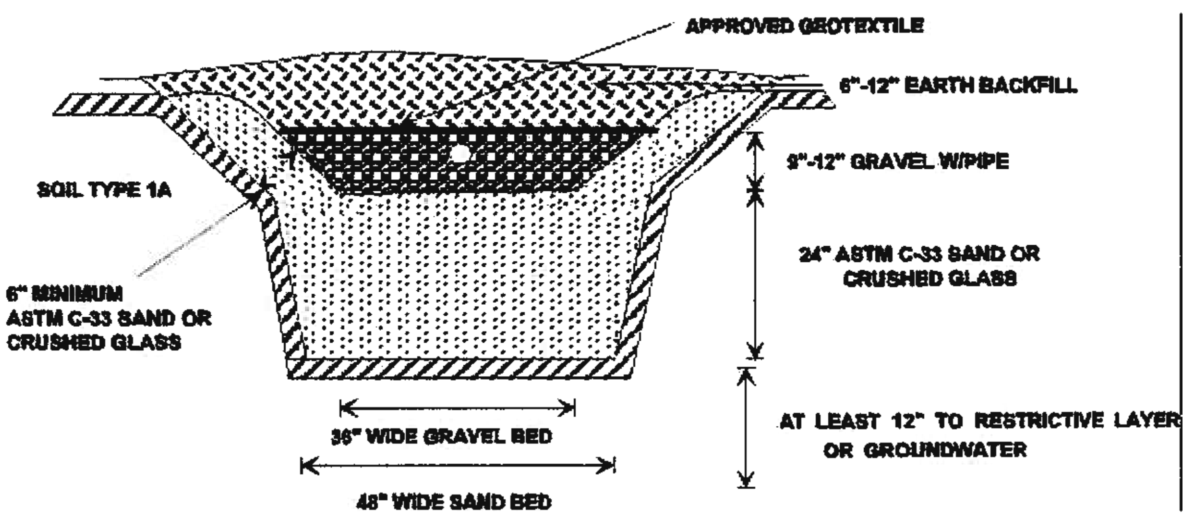


Figure 2.4 - Type 1A Soil Extending up into Gravel Bed (Option 3)

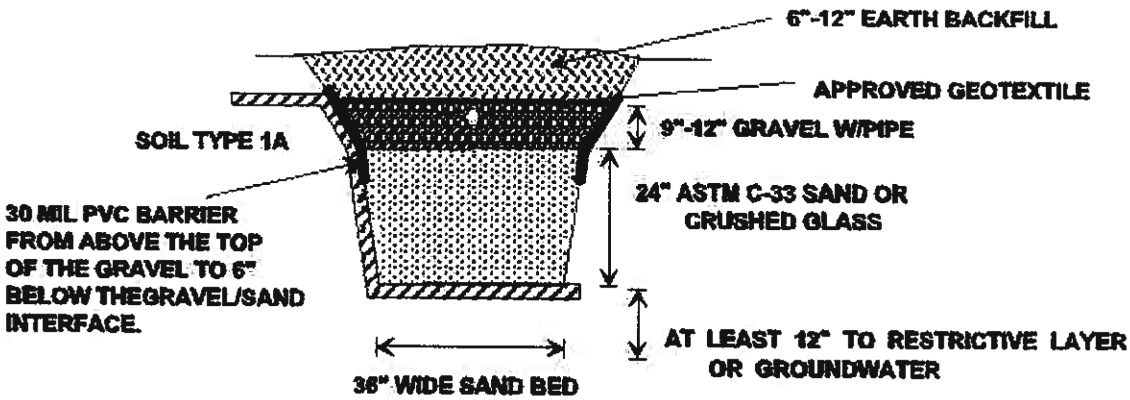


Figure 3 - Reaching More Suitable Soils at a Depth Greater Than 3 Feet **(EXAMPLE)**

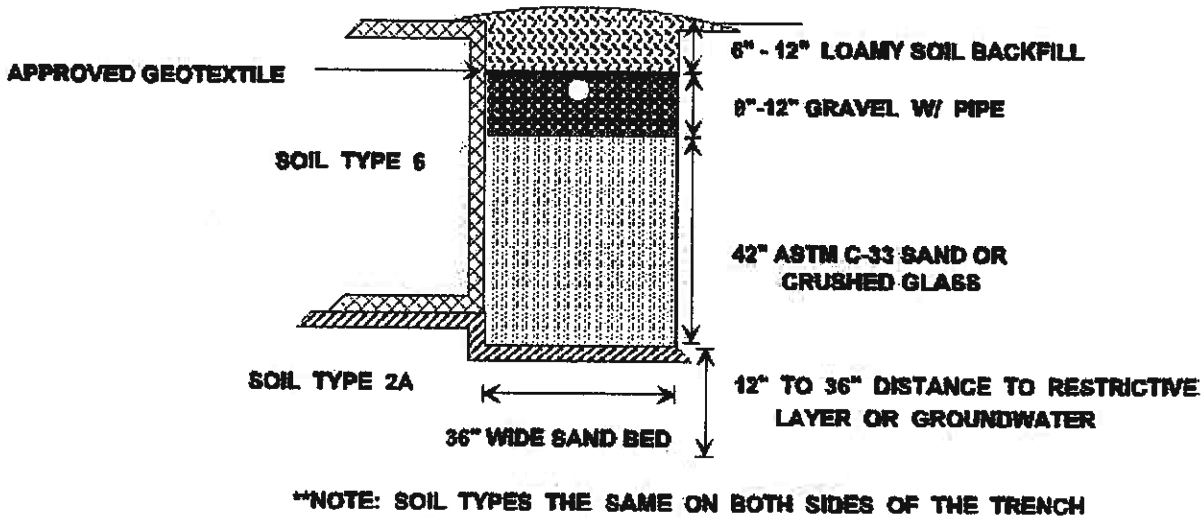
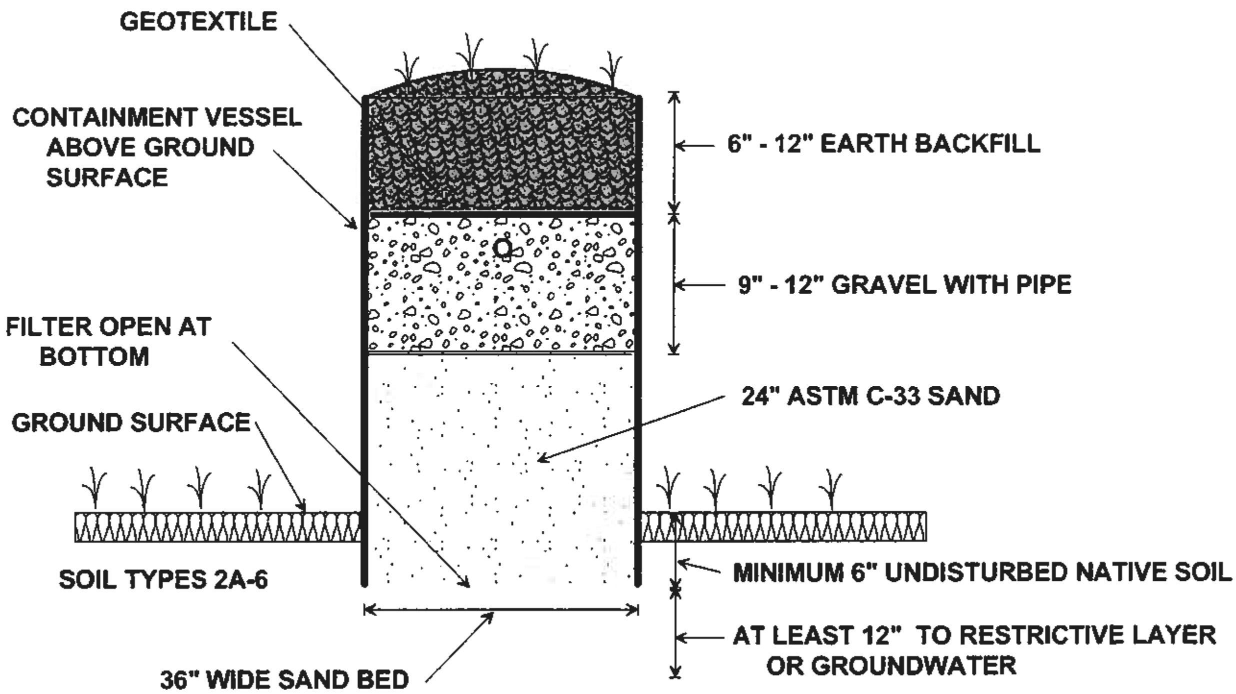


Figure 4 – Bottomless Sand Filter



2.0 Performance Standards

2.1 Based on sand column studies and field testing of intermittent sand filters, sand-lined trenches when constructed and used according to these standards and guidance, are expected to perform to treatment standard 2 levels. 10 mg/L BOD, TSS 800 / 40 f.coliform

2.2 The sand-lined trench must maintain 12 inches of vertical separation from the bottom of the trench.

3.0 Application Standards

3.1 **Listing** – Sand-lined trenches are a generic alternative technology and therefore are not listed in the department's List of Approved Systems and Products as a proprietary system, but may be permitted by local health officers as there is a DOH Standard and Guidance document available.

3.2 Permitting

3.2.1 Installation, and if required, operational, permits must be obtained from the appropriate local health officer prior to installation and use.

3.3 Influent Characteristics

3.3.1 Residential Wastewater: Sand-lined trenches are designed for treating residential strength wastewater. The wastewater applied to sand-lined trenches must not be higher in strength than 220 mg/l BOD_5 or 145 mg/l TSS (no TSS particles should be retained on a 1/8 inch mesh screen). Lower wastewater strengths, without increased flow rates are preferable for assuring long term operation of a sand-lined trench system.

3.3.2 Non-Residential Wastewater: High-strength wastewater and wastewater from non-domestic sources (such as restaurants, hotels, bed and breakfast establishments, industrial and commercial wastewater sources) must be individually evaluated for treatability and degree of pretreatment required prior to distribution to sand-lined trenches for final treatment and disposal.

3.3.3 Daily Wastewater Flow – Design Estimates

3.3.3.1 **Residential** – For all residential applications, a minimum wastewater design flow of at least 120 gallons/bedroom/day must be used.

3.3.3.2 **Non-Residential** – For non-residential applications, a minimum wastewater design flow equal to 150% of the estimated daily flow should be used.

3.4 Pretreatment –

3.4.1 If the wastewater is residential sewage, settleable and floatable solid separation by a properly sized two-compartment septic tank with effluent baffle screening will suffice.

Pretreatment with some other wastewater sedimentation/initial treatment unit may be used instead of a septic tank.

3.4.2 If the wastewater is from a non-domestic source, influent to the sand-lined trenches must be equivalent to residential strength septic tank effluent.

Aerobic treatment or some other treatment process may be needed to modify the influent to the sand-lined trenches to within the range of residential septic tank effluent quality.

3.5 Location Requirements

The minimum setback requirements for sand-lined trenches are the same as required for conventional drainfields (WAC 246-272-09501).

3.6 Installation Issues

3.6.1 In order to prevent differential settling when the sand-lined trench system is put into service, the filter media must have a uniform density throughout.

Uniform density may be accomplished one of two ways, depending on the moisture content of the filter media during construction. If the filter media is so dry that it can be poured (like salt or sand in an hourglass), it can simply be poured to fill the sand filter excavation, then settled lightly (not compacted) to allow about 5% settling -i.e., volume reduction. However, if the filter media is moist enough that it cannot be poured, it should be placed in successive 6-inch lifts with each lift lightly settled. The intent of the settling in both cases are no large voids in the media that will collapse later when effluent is added. The light settling may be accomplished by walking on the sand, then raking (with hand tools) into the corners, along the sides, around the pumpwell (if applicable) and around monitor ports. The final bulk density should be approximately 1.3 to 1.4 g/cm^3 (81.2 to 87.4 lb/ft^3). Higher densities will reduce infiltration rates and oxygen exchange potential.

3.6.2 A geotextile filter fabric must be placed on the gravel bed. The cover soil must be capable of maintaining vegetative growth while not impeding the passage of air (sandy loam or coarser).

3.6.3 **Observation ports:** Observation ports must be installed in at least two places in each drainfield line or bed. One observation port must be installed to the bottom of the drainrock/top of the media interface. A second observation port must be installed to the bottom of the media. See Appendix B for sample ports.

3.6.4 **Minimum soil depth for Sand-Lined Trench Effluent** – A minimum of 12 inches of vertical separation must be maintained where the treated effluent is applied to the native soil. These 12 inches must be free of the following conditions:

- the maximum seasonal high groundwater level
- a layer of creviced or porous bedrock
- a strata of impermeable soil or bedrock

3.6.4.1 The bottomless sand filter must be installed into a minimum of 6 inches of native undisturbed soil. To maintain a minimum of 12 inches of vertical separation from the bottom of the filter, a minimum of 18 inches of native, undisturbed soil is required.

4.0 Design

4.1 Design Approval – Before construction can begin, the design must be approved by local health or other appropriate jurisdiction. All site inspections before, during, and after the construction must be accomplished by local health, other appropriate jurisdiction, or by a designer or engineer appointed by the appropriate jurisdiction.

4.2 Filter Bed

4.2.1 **Media Specifications** – Filter media must meet the particle size criteria detailed in Appendix A. Media used in constructing a sand-lined trench must be accompanied with a written certification from the supplier that the media fully conforms to ASTM C-33 as determined by ASTM D136 and ASTM C-117.

4.2.2 Filter Bed Sizing

4.2.2.1 Loading Rates:

Soil Type	**Septic Tank Effluent Application Rate (GPD/ft^2)**	**Sand-Lined Trench Application Rate (GPD/ft^2) ****
Soil Type 1A, 2A: (Coarse sands, very gravelly coarse sands, extremely gravelly soils)	1.2	1.2[2]
Soil Type 1B:	Varies according to non-gravel portion	Varies according to non-gravel portion
Soil Type 2B: (Medium sand)	1.0	1.2[2]
Soil Type 3: (Fine sand, loamy sand)	0.8	1.2[2]
Soil Type 4: (Sandy loam, loam)	0.6	1.2[2]
Soil Type 5: (Porous, well-developed structure in silt and silt loams)	0.45	0.9
Soil Type 6: (Other silt loams, silty clay loams, and clay loams)	0.2	0.4 (Except where appreciable amounts of expandable clay are present)[1]

** Includes bottomless sand filters.

(see footnotes on following page)

[1] ***Please Note:*** *The following information has been provided by Lisa Palazzi to address the issue of appreciable amounts of expandable clay. Ms. Palazzi is a private-sector soil scientist and a member of the department's Technical Review Committee. A Vertisol is one of the 11 Taxonomic Soil Orders, and is defined as having slickensides (smeared planes within the soil profile) at least 10 inches thick within the top 40 inches of soil, and having 30% clay content and having cracks that open and close periodically. The slickensides and cracks imply that the clay content is primarily expanding clays, as those features occur concurrently only with expanding clays. Vertisols are identified in general textbooks as being generally incapable of supporting septic drainfields, although many septic systems are installed and functioning in Texas Vertisols. This success however, is thought to be a result of their very low rainfall climate.*

Expanding clays - such as montmorillonite or smectite or bentonite - can be defined on a mineralogic level as being composed of a 2:1 alumino-silicate crystalline lattice, as compared to non-expanding clays - such as kaolinite (the red Georgia clays) - which have a 1:1 crystal lattice form. From a more practical perspective, they can be defined by a measurement of how much they shrink when taken from a saturated water content to a dry water content. That measurement is called a Coefficient of Linear Extensibility (COLE) and a 9% change is considered definitive of having a significant montmorillonite content. At another scale, the distance between two montmorillonite crystal lattices when dry is reported as being 9.6 angstroms; and when exposed to 50% relative humidity, expanding to 10's or even hundreds of angstroms. So it is obvious that even a very small amount of expanding clay can have a huge effect on soil drainage characteristics. 5-10% content could be considered "appreciable".

It is important to note that there are few areas with expanding clays north of the terminus of the continental glacier (about Tenino for western Washington). Areas south of that however could have some Vertisols, although they are not terribly common. If we need a measure of expansion potential, the COLE process could be applied with fairly simple tools. One simply mixes a soil/water solution to the point where the clay soil is almost saturated, but can still be formed into a "worm" or rod-shaped lump. The length of the rod is measured. Then the rod is placed in an oven to dry (250 degrees for about an hour should be enough), then re-measured. If the length of the rod decreases by more than 3-5%, there is probably enough expanding clay to affect soil drainage potential. I chose 3-5% somewhat arbitrarily mainly because it is about one third to one half that of that used to indicate significant content of montmorillonite (9%).

[2] *A loading rate of 1.2 gpd/ft^2 may be too high for long term service. Recently, some concern has been expressed with premature failure and/or clogging of sand-lined trench systems with ASTM C-33 sand as the filter media. Several possible contributing factors have been discussed such as; a) the ASTM C-33 specification allows for too large of a percentage of fine material (passing a No. 100 sieve) which may cause the finer material to become suspended in the filter causing an impermeable barrier near the top of the filter, b) loading rates of 1.2 gal/ft^2/day are inappropriate and should be reduced. While the Technical Review Committee recognizes the concerns, the committee feels that the data presented is inconclusive at this time. Until modifications to the standards and guidance are made, some suggestions are as follows:*

A) *reducing loading rates applied to sand-lined trench systems to no more than 0.8 - 1.0 gal/ft^2/day*

B) *incorporating into the system design methods of improving oxygen exchange within the filter such as; increasing the dose frequency and/or including a venting system in the filter with vents extended to the atmosphere. Vents may need to include an odor scouring device such as an activated carbor filter installed on the end of the vent.*

C) *quality control of the sand media such as frequent testing of the media to ensure that the media used consistently meets the ASTM C-33 specification*

(a) Local health jurisdictions may have loading rates for the subsurface soil absorption system receiving sand lined trench system effluent that are different than those listed here. Check the local rules, policy or guidance on this issue.

(b) Replacement drainfield area must equal 100% of that required for conventional gravity gravel-filled drainfields receiving residential septic tank effluent according to WAC 246-272-11501.

4.2.2.2 **Surface area of filter bed/trench:** The surface area must be determined by dividing the design flow estimate by the loading rate.

4.2.2.3 **Depth of media:** if the sand-lined drainfield trench (sand filter) is selected to provide wastewater treatment before discharge to the receiving soil (see Figures 2.1, 2.2, 2.3, 2.4 and 4) there must be a minimum of 24 inches of filter media. If the sand-lined drainfield trench is selected to "reach" suitable soils (Soil Type 1B-6) and treatment conditions at a depth greater than 36 inches, it may not be necessary to have 24 inches of filter media depending upon the specific soil profile conditions *unless a reduction in drainfield size is applied.* It is necessary, however, that the depth of media and the vertical separation below the bottom of the trench add up to at least 36 inches to assure treatment.

4.2.2.4 **Filter Bed Width:** Absorption beds are allowed (in lieu of trenches) if the receiving soil is Type 1A, 1B, 2A, 2B and 3. Maximum bed width must be no greater than 10 feet.

4.2.3 **Filter media surface and excavation surfaces:** Both the filter media surface and the bottom of the excavation must be level.

4.2.4 **Filter bed containment (bottomless sand filter):** The bottomless sand filter containment vessel must be designed and/or approved by a qualified professional engineer and, where required by local and/or state regulation, the local health officer. The containment vessel must have a support foundation to prevent vertical and horizontal movement of the vessel.

4.3 Wastewater Distribution

4.3.1 **Pressure distribution:** Pressure distribution is required and must comply with the pressure distribution standards and guidance. This requirement applies to all pressure distribution related components.

4.3.2 **Wastewater application to the filter media:** The wastewater must be applied to the layer of drain rock atop the filter media, or sprayed upward against the top of gravelless chambers.

5.0 Operation and Maintenance

5.1 **Management –** The local health officer has the authority to require that an acceptable maintenance agreement be established, and supporting documents be developed and approved by the local health officer, prior to the issuance of approvals for a proposed sand filter sewage system. It is recommended that a maintenance agreement be required when, in the opinion of the local health authority, the ongoing operation of the sand-lined trench sewage system is best assured by the existence of such an agreement.

5.2 **User's Manual** – A user's manual for the sand-lined trench system must be developed and / or provided by the system designer. These materials must contain the following, at a minimum:

- ξ diagrams of the system components
- ξ Explanation of general system function, operational expectations, owner responsibility, etc.
- ξ Names and telephone numbers of the system designer, local health authority, component manufacturer, supplier/installer, and/or the management entity to be contacted in the event of a failure.
- ξ Information on the periodic maintenance requirements of the sewage system: septic tank, dosing tanks, sand-lined trenches, pumps, switches, alarms, etc.
- ξ Information on "Trouble-shooting" common operational problems that might occur. This information should be as detailed and complete as needed to assist the system owner to make accurate decisions about when and how to attempt corrections of operational problems, and when to call for professional assistance.

5.3 Maintenance

5.3.1 **Responsibility** – For the on-site treatment and disposal system to operate properly, its various components need periodic inspection and maintenance. The maintenance is the responsibility of the homeowner, but may be best performed by experienced and qualified service providers. An Operation and Maintenance Manual must be developed and/or provided by the system designer with copies provided to the local health officer, system owner and maintenance contractor. The maintenance manual must include the following listed recommended maintenance descriptions and schedules. The local health officer may specify additional requirements.

5.3.2 Minimum Maintenance Description and Service Items

5.3.2.1 Type of use.

5.3.2.2 Age of system.

5.3.2.3 Specifications of all electrical and mechanical components installed (occasionally components other than those specified on the plans are used).

5.3.2.4 Nuisance factors, such as odors or user complaints.

5.3.2.5 Septic tank: inspect yearly for structural integrity, proper baffling, screen, ground water intrusion, and proper sizing. Inspect and clean effluent baffle screen and also pump tank as needed.

5.3.2.6 Dosing tanks: clean the effluent screen (spraying with a hose is a common cleaning method), inspect and clean the pump switches and floats yearly. Pump the accumulated sludge from the bottom of the chambers, whenever the septic tank is pumped, or more often if necessary.

5.3.2.7 Check monitoring ports for ponding. Conditions in the monitoring ports must be observed and recorded by the service provider during all operation and maintenace activities for the sand lined trenches and other system components. For reduced size drainfields, these observations must be reported to the local health jurisdiction responsible for permitting the system.

5.3.2.8 Inspect and test yearly for malfunction of electrical equipment such as timers, counters, control boxes, pump switches, floats, alarm system or other electrical components, and repair as needed. System checks should include improper setting or failure, of electrical, mechanical, or manual switches.

5.3.2.9 Mechanical malfunctions (other than those affecting sewage pumps) including problems with valves, or other mechanical or plumbing components.

5.3.2.10 Malfunction of electrical equipment (other than pump switches) such as timers, counters, control boxes, or other electrical components.

5.3.2.11 Material fatigue, failure, corrosion problems, or use of improper materials, as related to construction or structural design.

5.3.2.12 Neglect or improper use, such as loading beyond the design rate, poor maintenance, or excessive weed growth.

5.3.2.13 Installation problems, such as improper location or failure to follow design.

5.3.2.14 Overflow or backup problems where sewage is involved.

5.3.2.15 Specific chemical/biological indicators, such as BOD, TSS, fecal or total coliforms, etc. Sampling and testing may be required by the local health oficer on a case-by-case basis, depending on the nature of the problem, availability of laboratories, or other factors.

5.3.2.16 Information on the safe disposal of discarded filter media. See Appendix C.

5.4 **Action Conditions** -- When inspections, or any other observation, reveals either of the following listed conditions, the owner of the system must take appropriate action, according to the direction and satisfaction of the local health officer:

- ξ Drainfield system failure, as defined in WAC 246-272-01001, or
- ξ a history of long-term, continuous and increasing ponding of wastewater within the reduced-size drainfield, which if left unaddressed, will probably result in untimely failure.

5.4.1 Appropriate Actions Upon Identification of Action conditions:

- ξ repair or modification of the drainfield system,
- ξ expansion of the drainfield system, or
- ξ modifications or changes within the structure relative to wastewater strength or hydraulic flows.

The repair or modification required may include the installation of additional drainfield to enlarge the system to 100% of the initial design size. Repair or modification is not limited to this option. Local permits must be obtained before construction begins, according to local health department requirements. Any repair or modification activity must be reported as part of the monitoring activity for the site.

Appendix A-- Filter Media Specifications

A. Particle Size Analysis

The standard method to be used for performing particle size analysis must comply with one of the following:

1. the sieve method specified in ASTM D136 and ASTM C-117
2. the method specified in Soil Survey Laboratory Methods and Procedures for Collecting Soil Samples, Soil Survey Investigation Report #1, US Department of Agriculture, 1984.

B. Sand-Lined Drainfield Trench Filter Media (ASTM C-33)

Media may be either mineral sand or crushed glass meeting all of conditions 1-4 below.

1. Particle size distribution:

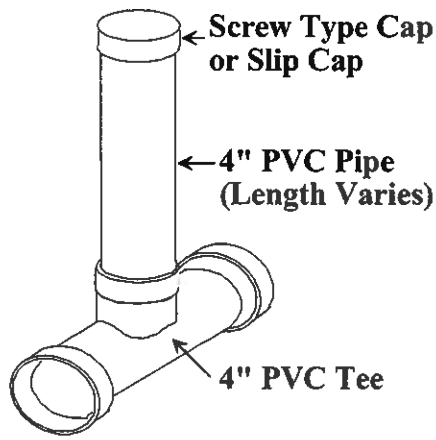
Sieve	Particle Size	Percent Passing
3/8 in	9.50 mm	100
No. 4	4.75 mm	95 to 100
No. 8	2.36 mm	80 to 100
No. 16	1.18 mm	50 to 85
No. 30	.60 mm	25 to 60
No. 50	30 mm	10 to 30
No. 100	.15 mm	2 to 10 (prefer <4)
No. 200	.075 mm	0 to 3 (prefer 0)

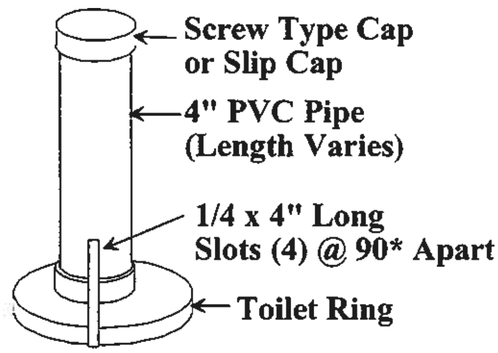
2. The sand must have not more than 45% passing any one sieve and retained on the next consecutive sieve, of those shown above.

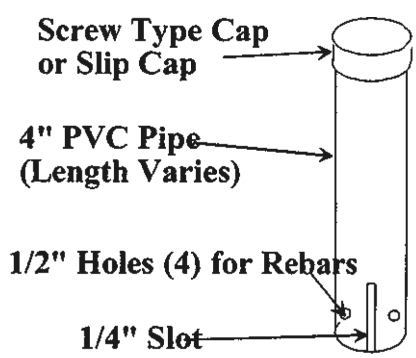
3. The fineness modulus must not be less than 2.3 nor more than 3.1, and is defined as a numeric quantity to control the distribution of filter media particle sizes within the specified range for sand lined trenches / beds. The fineness modulus is calculated by adding the cumulative percents of samples retained on the following screens, dividing the sum by 100.

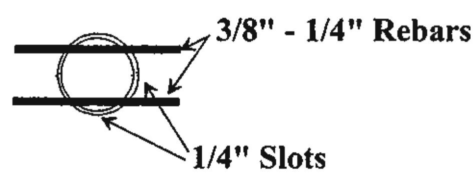
4. The limit for material that can pass the No. 200 sieve must not be more than 3%.

Appendix B--Inspection/Monitor Ports









<u>**END VIEW (BOTTOM)**</u>

Appendix C – Disposal of Contaminated Filter Media

Whenever filter media is removed from a used filter, removing and disposing of contaminated filter media is to be done in a manner approved by the local health officer. Handle this material carefully, using adequate protective sanitation measures. Thoroughly wash hands and any other exposed skin with hot water and soap, following contact with contaminated sand filter media.

This material may be applied to the soil, according to the following, only when approved by the local health officer.

	APPLICATION	RESTRICTIONS/TIMETABLE
1.	Root crops, low-growing vegetables, fruits, berries used for human consumption.	Contaminated material must be stabilized and applied 12 months prior to planting.
2.	Forage and pasture crops for consumption by dairy cattle.	Forage and pasture crops not available until one month following application of stabilized material.
3.	Forage and pasture crops for consumption by non-dairy livestock.	Forage and pasture crops not available until two weeks following application of stabilized material.
4.	Orchards or other agricultural area where the material will not directly contact food products. Or where stabilized material has undergone further treatment, such as pathogen reduction or sterilization.	Less severe restrictions may be applicable.

Appendix D

Glossary of Terms –

Term	Meaning / Description
Alternative System	An on-site sewage system other than a conventional gravity system or conventional pressure distribution system. Properly and maintained alternative systems provide equivalent or enhanced treatment performance as compared to conventional gravity systems.
Approved List	"List of Approved Systems and Products", developed annually and maintained by the department and containing the following: (a) List of proprietary devices approved by the department; (b) List of specific systems meeting Treatment Standard 1 and Treatment Standard 2; (c) List of experimental systems approved by the department; (d) List of septic tanks, pump chambers, and holding tanks approved by the department.
Biological Oxygen Demand (BOD_5)	An index of the amount of oxygen that will be consumed by the decomposition of organic matter in a wastewater. This is the result of a laboratory analysis that consists of measuring the initial dissolved oxygen concentration, incubating the sample for five days at 68° F, then measuring the final dissolved oxygen. The difference in dissolved oxygen concentration corrected for the initial dilution and sample volume is called the BOD_5. The BOD_5 test is one of the commonly used indicators of wastewater strength.
Coliform (Bacteria)	A group of bacteria that produce gas and ferment lactose, some of which are found in the intestinal tract of warm-blooded animals. They are indicators of potential ground water and/or surface water contamination with such fecal material.
Conventional Gravity System	An on-site sewage system consisting of a septic tank and a subsurface soil absorption system with gravity flow distribution of the effluent.
Conventional Pressure Distribution System	An on-site sewage system consisting of a septic tank and a subsurface soil absorption system with pressure distribution of the effluent.
Demand System	Any system where the dosing frequency (or flow to a treatment or disposal component) is controlled by the volume of effluent flowing to the component. For a demand system containing a pump and pressure distribution system, the pump turns on when sufficient volumes (demand) flow into the chamber causing the pump-on float to activate and the predetermined dose volume to be discharged to the treatment and / or disposal component which follows.
Disposal Component	A subsurface absorption system (SSAS) or other soil absorption system receiving septic tank or other pretreatment device and transmitting it into original, undisturbed soil.
Dosing Tank / Chamber	A tank which collects treated effluent and periodically discharges it into another treatment / disposal component, depending upon the needs and design of the particular on-site sewage system.
Drain Rock	Clean, washed gravel, varying in size from ¾ inch to 2 ½ inches.
Drainfield (Conventional)	An area in which perforated piping is laid in drain rock-packed trenches, or excavations (seepage beds) for the purpose of distributing the effluent from a wastewater treatment unit into original, undisturbed soil.
Effective Particle Size, CE=C90	The size of opening of an ideal sieve which would retain 90% of a sample, while passing 10% of the sample.
Effluent	Liquid which is discharged from an on-site sewage system component, such as a septic tank (septic tank effluent) or sand filter (sand filter effluent).
Excreta	Human urine and feces.
Experimental System	Any alternative system without design guidelines developed by the department or a proprietary device or method which has not yet been evaluated and approved by the department.
Failure	A condition of an on-site sewage system that threatens the public health by inadequately treating sewage or creating a potential for direct or indirect contact between sewage and the public. Examples of failure include: (a) sewage on the surface of the ground; (b) sewage backing up into a structure caused by slow absorption of septic tank effluent; (c) sewage leaking from a septic tank, pump chamber, holding tank, or collection system; (d) cesspool or seepage pits where evidence of ground water or surface water quality degradation exists; or

Term	Meaning / Description
	(e) inadequately treated effluent contaminating ground water or surface water. (f) noncompliance with standards stipulated on the permit.
Fats, Oils & Greases (Fog)	FOG is a measure of the amount of fatty matter from animal and vegetable sources and hydrocarbons from petroleum products and waxes, such as from lotions, shampoos, and tanning oils. High levels of fats, oils and greases in the wastewater stream may interfere with wastewater treatment efficiency.
Fecal Coliform (Bacteria)	Coliform bacteria specifically originating from the intestines of warm-blooded animals, used as a potential indicator of ground water and/or surface water pollution.
Filter	A device or structure for removing suspended solid or colloidal material from wastewater.
Filter Media	The material through which wastewater is passed for the purpose of treatment.
Filtrate	Liquid which has passed through a filter.
Final Treatment/Disposal Unit	That portion of an on-site sewage system designed to provide final treatment and disposal of the effluent from a wastewater treatment unit, including, but not limited to, absorption fields (drainfields), sand mounds and sand-lined trenches.
Fineness Modulus	A numeric quantity to control the distribution of filter media particle sizes within the specified range for intermittent sand filters. It is calculated by adding the cumulative percents of samples retained on the following screens, divided by 100.
Geomembrane	An essentially impermeable membrane used with foundation, soil, rock, earth or any other geotechnical engineering-related material as an integral part of a human-made project, structure, or system.
Geotextile	Any geotechnical engineering-related permeable textile used with foundations, soil, rock, earth, an integral part of a human-made project, structure, or system, and which serves to lessen the movement of fine soil particles.
Infiltrative Surface	In drainfields, the drain rock-original soil interface at the bottom of the trench; in mound systems, the gravel-mound sand and the sand-original soil interfaces; in sand-lined trenches/beds (sand filter), the gravel-sand interface and the sand-original soil interface at the bottom of the trench or bed.
Influent	Wastewater, partially or completely treated, or in its natural state (raw wastewater), flowing into a reservoir, tank, treatment unit, or disposal unit.
On-Site Sewage System	An integrated arrangement of components for a residence, building, industrial establishment or other places not connected to a public sewer system which: (a) Convey, store, treat, and/or provide subsurface soil treatment and disposal on the property where it originates, upon adjacent or nearby property; and (b) Includes piping, treatment devices, other accessories, and soil underlying the disposal component of the initial and reserve areas.
Particle Size	The diameter of a soil or sand particle, usually measured by sedimentation or sieving.
Percolation	The flow or trickling of a liquid downward through a contact or filtering medium. The liquid may or may not fill the pores of the medium.
Pressure Distribution	A system of small diameter pipes that apply effluent fairly uniformly over the entire absorption area, as described in the "Recommended Standards and Guidance for Pressure Distribution Systems" by the Washington State Department of Health. (See Conventional Pressure Distribution System.)
Proprietary Device Or Method	A device or method classified as an alternative system, or a component thereof, held under a patent, trademark or copyright.
Pump Chamber	A tank or compartment following the septic tank or other pretreatment process which contains a pump, floats and volume for storage of effluent. In timer-controlled pressure distribution systems, this is frequently called a "surge tank" or "equalization tank." If a siphon is used, in lieu of a pump, this is called a "siphon chamber."
Raw Wastewater	Wastewater before it receives any treatment.
Residential Sewage	Sewage having the consistency and strength typical of wastewater from domestic households.
Restrictive Layer	A stratum impeding the vertical movement of water, air, and growth of plant roots, such as hardpan, clay pan, fragipan, caliche, some compacted soils, bedrock and unstructured clay soils.
Routine Servicing	Servicing all system components as needed, including product manufacturer's requirements / recommendations for service.
Sand Filter	A biological and physical wastewater treatment component consisting (generally) of an under drained bed of sand to which pre-treated effluent is periodically applied. Filtrate collected by

Term	Meaning / Description
	the under drains is then disposed of by an approved soil absorption system. Pretreatment can be provided by a septic tank or another approved treatment component. An Intermittent Sand Filter is a sand filter in which pre-treated wastewater is applied periodically providing intermittent periods of wastewater application, followed by periods of drying and oxygenation of the filter bed. A Recirculating Sand (Gravel) Filter is a sand (gravel) filter which processes liquid waste by mixing filtrate with incoming septic tank effluent and recirculating it several times through the filter media before discharging to a final treatment/disposal unit. Sand-Lined Drainfield Trench is a combination of a pressure distribution drainfield and an intermittent sand filter consisting of a two-foot layer of intermittent sand filter media placed directly below the drain rock layer in the pressure distribution drainfield trench. A Bottomless Sand Filter is a special case of a sand-lined drainfield trench installed in a containment vessel and is usually used to utilize more suitable soils high in the soil profile for disposal.
Septic Tank	A water tight pretreatment receptacle receiving the discharge of sewage from a building sewer or sewers, designed and constructed to permit separation of settleable and floating solids from the liquid, detention and anaerobic/facultative digestion of the organic matter, prior to discharge of the liquid.
Service Interval	The time period between planned site visits to perform various system monitoring functions such as checking equipment, renewing depleted disinfectant chemical supply, collecting samples. The service intervals may be specified by contracts, operation plans, or local health jurisdiction permits.
Sewage	Any urine, feces, and the water carrying human wastes including kitchen, bath, and laundry wastes from residences, building, industrial establishments or other places. For the purposes of this document, "sewage" is generally synonymous with domestic wastewater. Also see "residential sewage."
Soil Type 1A	Very gravelly coarse sands or coarser, extremely gravelly soils.
Subsurface Soil Absorption System - "SSAS"	A system of trenches three feet or less in width, or beds between three feet and ten feet in width, containing distribution pipe within a layer of clean gravel designed and installed in original, undisturbed soil for the purpose of receiving effluent and transmitting it into the soil.
Suitable Soil	Original, undisturbed soil of types 1B through 6.
Synthetic Filter Fabric	See Geotextile.
Synthetic Membrane	See Geomembrane.
Timer-Controlled System	A pressure distribution system where the pump on and off times are preset, discrete time periods.
Total Suspended Solids (TSS)	Suspended solids refer to the dispersed particulate matter in a wastewater sample that may be retained by a filter medium. Suspended solids may include both settleable and unsettleable solids of both inorganic and organic origin. This parameter is widely used to monitor the performance of the various stages of wastewater treatment, often used in conjunction with BOD5 to describe wastewater strength. The test consists of filtering a known volume of sample through a weighed filter membrane that is then dried and re-weighed.
Treatment Component	A class of on-site sewage system components that modify and/or treat sewage or effluent prior to the effluent being transmitted to another treatment component or a disposal component. Treatment occurs by a variety of physical, chemical, and/or biological means. Constituents of sewage or effluent may be removed or reduced in concentrations.
Treatment Standard 1	A thirty-day average of less than 10 mg/l of BOD_5 and 10 mg/l of total suspended solids and a thirty-day geometric mean of less than 200 fecal coliform/100ml.
Treatment Standard 2	A thirty-day average of less than 10 mg/l of BOD_5 and 10 mg/l of total suspended solids and a thirty-day geometric mean of less than 800 fecal coliform/100ml.
Uniformity Coefficient, CU	A numeric quantity which is calculated by dividing the size of the opening which will pass 60% of a sample by the size of the opening which will pass 10% of the sample. (symbolically C60/C10=CU)
Vertical Separation	The depth of unsaturated, original, undisturbed soil of Soil types 1B - 6 between the bottom of a disposal component and the highest seasonal water table, a restrictive layer, or Soil Type 1A.
Wastewater	Water-carried human excreta and/or domestic waste from residences, buildings, industrial establishments or other facilities. (See sewage.)
Wastewater Design Flow	The volume of wastewater predicted to be generated by occupants of a structure. For residential dwellings, this volume is calculated by multiplying the number of bedrooms by the estimated number of gallons per day (gpd), using either the minimum state design standard (120 gpd) or the locally established minimum standard (such as 150 gpd).

Term	Meaning / Description
Wastewater Treatment Unit	A unit designed, constructed, and installed to stabilize liquid waste by biochemical and physical action.

Appendix E

Bibliography

A. Boyle, W.C. and Richard J. Otis, "On-Site Treatment", EPA Training Manual, Prepared for Environmental Research Information Center, ORD, USEPA, July 1979.

B. Design Manual: On-site Wastewater Treatment and Disposal Systems. U.S. EPA, EPA-625/1-80-012 October 1980

C. Final Report, Oregon On-site Experimental Systems Program, December 1982; Oregon Department of Environmental Quality

D. Glossary of Water and Wastewater Control Engineering; Joint Editorial Board of the AWWA, WPCF, ASCE, APHA, Copyright 1969

E. Gross, Mark A., Optimum Depth Of Sand For Filtering Septic Tank Effluent; Masters Degree Thesis, Master of Science, University Of Arkansas, 1981.

F. Gross, Mark, Dee T. Mitchell, Biological Virus Removal From Household Septic Tank Effluent; Proceedings of the Fourth National Symposium on Individual and Small Community Sewage Systems, ASAE, December 1984, New Orleans, Louisiana.

G. Gross, Mark, Ph.D., P.E., Dee Mitchell, Household Wastewater Virus Removal by Sand Filtration; 1988 Revision.

H. Hathaway, Randy J., Dee T. Mitchell, Sand Filtration of Septic Tank Effluent For All Seasons Disposal By Irrigation, Proceedings of the Fourth National Symposium on Individual and Small Community Sewage Systems, December 1984, New Orleans, Louisiana

I. Hines, Michael and R.E. Favreau, Recirculating Sand Filter: An Alternative to Traditional Sewage Absorption Systems, Proceedings of National Home Sewage Disposal Symposium, December 1974.

K. Loudon, T.L., G.L. Birnie, Jr., Performance of Trenches Receiving Sand Filter Effluent in Slowly Permeable Soils, Proceedings of the 6th National Symposium on Individual and Small Community Sewage Systems, ASAE, December, 1991, Chicago, IL.

L. Management of Small Waste Flows, Final Report of the Small Scale Management Project, University of Wisconsin, EPA 600/2-78-173.

M. Mitchell, Dee, Sand Filtration of Septic Tank Effluent, Proceedings of the 5th Northwest On-site Wastewater Treatment Short Course, University of Washington, September 1985

N. Mitchell, Mike D. P.E., Writings, Northwest Septic, Inc., Mt. Vernon, Washington.

O. On the Performance of Experimental Sand Filters in the State of Oregon, Oregon Department of Environmental Quality.

J. Koerner, Robert M., Ph.D., P.E., Designing with Geosynthethics, Prentice-Hall

P. Otis, Richard, P.E., Soil Clogging: Mechanisms and Control, Proceedings of the 4th National Symposium on Individual and Small Community Sewage Systems, ASAE, December 1984, New Orleans, LA.

Q. Otis, Richard J., P.E., On-site Wastewater Treatment Intermittent Sand Filters, Rural Systems Engineering, Madison, Wisconsin.

R. Sauer, D.K., W.C. Boyle, and Richard J. Otis. "Intermittent Sand Filtration." ASCE/EE, August 1976

S. Scherer, Billy P., Dee T. Mitchell, Individual Household Surface Disposal of Treated Wastewater Without Chlorination; Proceedings of the Third National Symposium on Individual and Small Community Sewage Treatment, December 1981, Chicago, Illinois.

T. Siegrist, Robert L., Hydraulic Loading Rates for Soil Absorption Systems Based on Wastewater Quality, Proceedings of the 5th National Symposium on Individual and Small Community Sewage Systems, ASAE, December 1987, Chicago, IL

U. Technology Assessment of Intermittent Sand Filters. U.S. EPA, Office of Municipal Pollution Control, Project Officer: James F. Kreissl. Authors: Damann L. Anderson, Robert L. Seigrist, Richard J. Otis.

V. Tyler, E. Jerry, James C. Converse, Soil Acceptance of Onsite Wastewater as Affected by Soil Morphology and Wastewater Quality, Proceedings of the 7th International Symposium on Individual and Small Community Sewage Systems, ASAE, December 1994, Atlanta, GA.